

CLAIMS

What is claimed is:

- 1 1. A fast steering mirror, comprising:
2 a base member;
3 an outer gimbal, pivotally coupled to the base member;
4 an inner gimbal, pivotally coupled to the outer gimbal;
5 a mirror fixedly coupled to the inner gimbal;
6 a first pair of voice coil drivers comprising a first pair of magnetized stators
7 fixedly coupled to the base member and a first pair of voice coils fixedly coupled to
8 the outer gimbal; and
9 a second pair of voice coil drivers comprising a second pair of magnetized
10 stators fixedly coupled to the base member and a second pair of voice coils fixedly
11 coupled to the inner gimbal.
- 1 2. The fast steering mirror of claim 1, wherein each of said first and second pair
2 of voice coils comprise a cylindrical shell-shaped bobbin having a plurality of
3 conductive coils wound around an external portion thereof.
- 1 3. The fast steering mirror of claim 1, wherein each of said first and second pair
2 of magnetized stators comprise a generally can-shaped member made of a
3 magnetically permeable material in which an annular magnet is disposed.

1 4. The fast steering mirror of claim 3, wherein the generally can-shaped
2 member further comprises an internal post extending upward from a base portion
3 thereof.

1 5. The fast steering mirror of claim 1, wherein the outer gimbal includes a pivot
2 axis and is configured such that the outer gimbal and the first pair of voice coils
3 fixedly coupled thereto have a combined center of gravity through which the pivot
4 axis substantially passes.

1 6. The fast steering mirror of claim 1, wherein the inner gimbal includes a pivot
2 axis and is configured such that the outer gimbal and the second pair of voice coils
3 fixedly coupled thereto have a combined center of gravity through which the pivot
4 axis substantially passes.

1 7. The fast steering mirror of claim 1, wherein the outer gimbal has a first pivot
2 axis and the inner gimbal has a second pivot axis that is substantially orthogonal to
3 the first pivot axis.

1 8. The fast steering mirror of claim 7, wherein the mirror is disposed relative to
2 the inner gimbal such that that mirror contain a common point on its surface through
3 which both the first and second pivot axes pass.

1 9. The fast steering mirror of claim 1, wherein the outer gimbal is pivotally
2 coupled to the base member via a pair of flex pivots.

1 10. The fast steering mirror of claim 1, wherein the inner gimbal is pivotally
2 coupled to the base member via a pair of flex pivots.

1 11. The fast steering mirror of claim 1, wherein the base member comprises:
2 a base having an upper surface to which the first and second pairs of
3 magnetized stators are fixedly coupled; and
4 a frame, having a bottom surface fixed coupled to the upper surface of the
5 base and having a pair of supports extending upward from opposite corners
6 therefrom to which the outer gimbal is pivotally coupled.

1 12. The fast steering mirror of claim 1, further comprises a driver board
2 containing drive circuitry to provide drive currents to drive the first and second pairs
3 of voice coils and means for electrically connecting each of said drive currents to a
4 respective voice coil.

1 13. The fast steering mirror of claim 12, wherein each of the first and second
2 pairs of voice coils are configured such that the drive current for one voice coil in
3 each pair of voice coils generates magnetic lines of flux that have a direction that is
4 opposite to the magnetic lines of flux for the other voice coil in the pair.

1 14. The fast steering mirror of claim 1, further comprising an optical-based
2 feedback and control mechanism to enable the mirror to be positioned in a
3 reference position.

1 15. A fast steering mirror, comprising:
2 a base member;

3 an outer gimbal, pivotally coupled to the base member;
4 an inner gimbal, pivotally coupled to the outer gimbal;
5 a mirror fixedly coupled to the inner gimbal;
6 a first pair of voice coil drivers comprising a first pair of magnetized stators
7 fixedly coupled to the base member and a first pair of voice coils fixedly coupled to
8 the outer gimbal; and
9 a second pair of voice coil drivers comprising a second pair of magnetized
10 stators fixedly coupled to the base member and a second pair of voice coils fixedly
11 coupled to the inner gimbal;
12 a control system configured to receive a position feedback signal and
13 generate drive currents in response thereto to drive each of the voice coils in the
14 first and second pairs of voice coils to control a position of the mirror; and
15 means for connecting drive current outputs of the control system to each of
16 the voice coils in the first and second pairs of voice coils.

1 16. The fast steering mirror of claim 15, wherein the control system includes
2 programmed logic comprising an algorithm that determines a positional error based
3 on the position feedback signal and generates appropriate drive currents to adjust
4 the position of the mirror such that the positional error is reduced.

1 17. The fast steering mirror of claim 16, wherein the algorithm is processed using
2 a digital signal processor (DSP).

1 18. The fast steering mirror of claim 16, wherein the DSP is contained on a circuit
2 board that is external to the fast steering mirror, further comprising a computer
3 interface that enables signals to be communicated between the circuit board and the

4 fast steering mirror over a cable connected between the circuit board and the fast
5 steering mirror.

1 19. The fast steering mirror of claim 15, wherein the control system includes a
2 printed circuit board operatively coupled to the base member that includes
3 amplification circuitry to drive the voice coils.

1 20. The fast steering mirror of claim 15, further including:
2 a reflector, coupled to a backside of the mirror;
3 an emitter to emit light that is directed toward the reflector; and
4 a light beam position detector; receiving a portion of light reflected from the
5 reflector,
6 wherein the control system includes a reference positioning mode that uses a
7 feedback signal produced by the light beam position detector in response to the
8 portion of light it receives to position the mirror in a reference position.

1 21. The fast steering mirror of claim 20, further including a lens disposed
2 between the reflector and the light position detector to focus light reflected by the
3 reflector onto the light beam position detector.

1 22. The fast steering mirror of claim 20, further including a pin-hole aperture
2 disposed between the emitter and the reflector to direct a portion of the light emitted
3 by the emitter toward the reflector.

1 22. The fast steering mirror of claim 15, wherein the means for connecting the
2 drive current outputs of the control system to each of the voice coils comprises flex
3 circuits.

1 23. The fast steering mirror of claim 15, wherein each of the first and second
2 pairs of voice coils includes windings that are connected in series such that a
3 current flowing through the windings causes one of the voice coils in a pair to
4 generate a push force away from its corresponding magnetic stator while the other
5 voice coil in the pair generated a pull force toward it corresponding magnetic stator.

1 24. The fast steering mirror of claim 15, wherein each of the voice coils in said
2 first and second pair of voice coils comprises a cylindrical shell-shaped bobbin
3 having a plurality of conductive coils wound around an external portion thereof.

1 25. The fast steering mirror of claim 15, wherein each of the magnetized stators
2 in said first and second pair of magnetized stators comprises a generally can-
3 shaped member made of a magnetically permeable material in which an annular
4 magnet is disposed.

1 26. The fast steering mirror of claim 25, wherein the generally can-shaped
2 member further comprises an internal post extending upward from a base portion
3 thereof.